Energy utilization of CO2 in converter smelting

Member company

China Baowu Steel Group Corporation - TISCO

The Challenge

CO₂ recycling in the steelmaking process, CO₂ converter bottom-blowing technology, converter top-blowing CO₂ energization technology.

Why?

China Baowu TISCO Group is the largest joint producer of stainless steel and carbon steel in China, the recycling of CO2 is of great significance for TISCO Group to complete the task of energy saving and emission reduction. In addition, because stainless steel production requires the consumption of large amounts of argon, the price of argon is 2-3 times the price

1. The gas recovery can be increased by of CO2, the use of CO2 to replace argon 6.57Nm3/t. The average amount of is an effective way to reduce the cost of steelmaking production. extra pure CO recovered per furnace is 674Nm3, which is 59Nm3 more than **Needed** action the CO₂ consumed, indicating that all the blown-in CO₂ is converted into CO.

1. Carbon steel converter top blowing CO₂, increase gas recovery, to prevent the explosion of the electric dedusting

After CO₂ is blown into the converter top gun, the C in the iron water reacts with CO₂ to produce CO twice as much as that produced by the reaction with oxygen, which can rapidly increase the CO content in the exhaust gas and advance the node of gas recovery, and the CO content in the recovered gas is higher than that of all top-blown oxygen (see Figure 1). Through production data statistics, the relevant furnace times with and without CO₂ in the top gun are compared separately.

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- 2. The total gas recovery time is increased by 53s/furnace and the start of recovery time is advanced by 68s, which indicates that the gas recovery time can be effectively improved when top blowing CO_2 .
 - 3. From the above theoretical analysis and field practical verification, the converter smelting process can convert all CO₂ into CO and realize the purpose of CO₂ energy recycling.

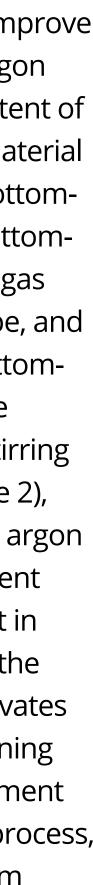
2. Carbon steel converter bottomblowing CO, instead of argon

In order to improve the bottom-blow

stirring intensity of the converter, improve the proportion of CO₂ instead of argon while reducing the end oxygen content of the converter, steel and auxiliary material consumption, and the converter bottomblow system was optimized, the bottomblow element was changed from a gas permeable brick to a metal ring tube, and the number and location of the bottomblow holes were optimized, and the bottom-blow control system and stirring process were developed (see Figure 2), which was effective in reducing the argon consumption, the end oxygen content of the molten steel and TFe content in the slag. As the implementation of the bottom-blowing CO₂ process aggravates the bottom erosion, shortens the lining life and affects the overall advancement of the top-bottom re-blowing CO₂ process, the converter online thermal bottom replacement technology was developed



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to completely solve the problem of rapid bottom erosion. From the first bottom replacement on October 9, 2021 to the end of 2022, the bottom was successfully replaced four times, with an average time of 17 hours per bottom replacement, and the longest number of times the small bottom was used after replacement was 4271 and the shortest was 3631, which solved the problem of promoting the CO process in the converter.2

After our theoretical study on the application of CO₂ to replace argon in stainless steel converter, we carried out tests under different smelting stages and gas distribution process conditions, and conducted a comprehensive comparison in terms of temperature, consumption, resistant material erosion and reduction, respectively, to determine that CO₂ can be used in the stainless steel smelting

process. But in the current process gas by about 13,000 tons. Reduce 2,700 conditions of iron + alloy smelting process tons of ferro-silicon used for controlling heat is insufficient, and the use of CO₂ the electric dust discharge explosion and heat absorption exacerbates the problem. increase gas recovery by 17 million m3, From economic considerations, CO₂ can which has achieved significant effect of only partially replace argon in the current reducing argon consumption, increasing stainless steel smelting process, and the gas recovery and reducing CO₂ emission. proportion of ultra-pure ferritic stainless *Achievable*: By comparing the analysis steel CO₂ replacing Ar is stabilized at about 25% (about 5 Nm³/t).

Action review

Specific: The converter production needs to consume a large amount of argon gas, the price of argon gas is 2-3 times the price of CO₂, using CO₂ to replace argon gas can reduce the cost of steel production, while the converter top blowing CO₂ can increase the amount of converter gas recovery.

Measurable: From June 2020-October 2022, it will replace only the use of argon

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before and after use, without considering the reduction of steel and deoxidizer consumption, from June 2020 to October 2022, the cost saving of using CO₂ alone is 35.23 million RMB.

Realistic: The project realizes the resource and energy utilization of CO₂ in the smelting process of stainless steel and carbon steel, reduces CO₂ emissions, and is of great significance to the energy saving and emission reduction and green development of the steel industry.

Time-bound: The project was completed on schedule and achieved the desired results.

Horizontal Expansion Capability

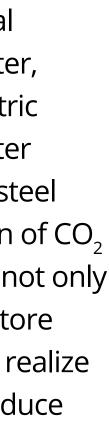
The company has overcome a series of technical problems in the use of CO₂ around the energy saving and emission reduction and green development of the industry, and developed a number of international leading process technologies such as online thermal bottom replacement of the converter, top blowing CO₂ control of the electric de-dusting explosion in the converter and the use of CO₂ in the stainless steel converter. The industrial application of CO₂ in TISCO's steelmaking process cannot only reduce production costs, but also store CO_2 in the form of converter gas to realize the energy utilization of CO₂ and reduce











carbon emissions. This technology can be promoted in the industry to drive energy saving and emission reduction in the steel industry.

Outcome

Since June 2020, the use of CO₂ to replace argon gas to form a large-scale application. By the end of 2022, the cumulative use of carbon dioxide gas is about 31,000 tons, replacing about 13,000 tons of purchased argon gas, reducing 2,700 tons of ferro-silicon used for controlling electric dedusting and increasing gas recovery by 17 million m³, which has achieved a significant effect of reducing argon gas consumption, increasing gas recovery and reducing carbon dioxide emission. Only the use of CO_2 a cost savings of 35.23 million yuan.

Other comments

At present, TISCO's CO₂ is sourced from external sources, and the usage quantity and cost are limited. After the completion of TISCO's CO₂ internal capture project in 2023, the annual output is expected to reach 50,000-60,000 tons, and in order to maximize the internal recycling of CO₂, the usage field and scale of CO₂ need to be further expanded, and the use of CO₂ as a protective gas for continuous casting and ladle stirring gas instead of Ar needs to be further studied, and the use of CO₂ in the treatment of slag needs to be promoted. The use of CO₂ in the process of steel slag treatment should be promoted, and the use of CO should be increased and its emission reduced.

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